

## Conversion of Light to Biochemical Energy using a Tethered Membrane System



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Nature has developed different types of photosynthetic molecular assemblies in bacteria, algae and plants. However, in each case the conversion of light into adenosine triphosphate (ATP) is the starting point of anabolic metabolism. One of the most rugged systems for the conversion of light energy into biochemical energy of ATP exists in archaeobacteria. In a first step towards mimicking this process in an artificial membrane we have combined the stability of a solid-supported tethered lipid membrane [1] based on archaeobacterial lipids with the light-to-electrochemical energy converting protein, bacteriorhodopsin (bR) [2].

The tethered membrane system is formed onto gold substrates by a gold-sulfur self-assembly process. The membrane spanning lipid contains both a 4nm lipid region as well as a 4nm hydrophilic, oligoethylene glycol region which forms an ionic reservoir between the gold electrode and the lipid membrane. Although the membrane is chemically tethered to the gold surface and hence mechanically stable, the presence of the ionic reservoir means that the system more closely mimics natural cell systems.

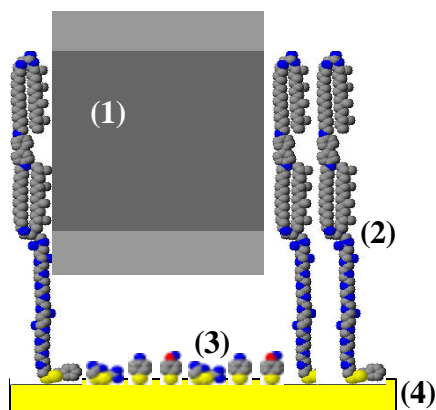


Fig 1. Model cross-section of the tethered lipid bilayer structure containing bacteriorhodopsin

(1) bacteriorhodopsin, (2) full membrane spanning lipids, (3) spacer molecules and (4) solid surface

Using electrical and electrochemical techniques we have shown that oriented bR can be successfully incorporated into such tethered lipid membranes. This was seen as a directed proton flux across the lipid membrane into the ionic reservoir in the presence of light. Results obtained were similar to those obtained with Black Lipid Membrane experiments [3]. The current system combines relatively high photoresponses with the stability of tethered archaeobacterial lipid membranes.

This type of artificial lipid membrane has the potential to act as a matrix for other membrane proteins. An additional advantage of the ionic reservoir is that it allows the incorporation of membrane proteins with large extracellular regions. Work is under way to use pH dependent redox couples to directly measure the pH change in the ionic reservoir region. Incorporation of  $F_0F_1$ -ATPase, which can use the pH gradient to synthesise ATP is the next step in the production of an artificial leaf.

[1] Cornell BA, Braach-Maksvytis VLB, King LG, Osman PDJ, Raguse B, Wieczorek L, Pace RJ; NATURE 387, 580-583 1997

[2] He J-A, Samuelson L, Li L, Kumar J, Tripathy SK; Adv. Mater. 11,6 435-446 1999

[3] Oesterheld D, Tittor J, Bamberg E; J. Bioenerg. Biomembr. 24, 181-191 1992